Chemical Control and Integrated Pest Management of Woolly Whitefly[1]

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Abstract

Five foliar insecticide treatments (Esteem, two rates of Provado, two rates of Applaud, Prev-am, and Danitol + Lorsban) were evaluated for their control of woolly whitefly infestations in grapefruit. All of these products demonstrated efficacy in mitigating woolly whitefly populations. Danitol + Lorsban was the best knock-down treatment evaluated, but for sustained control, Esteem appeared to be most effective. Applaud demonstrated good activity, but the rate we tested may be a little low; the 1.0 lb/ac rate should be evaluated. Provado at 19 oz/ac was a good treatment, while the 10 oz/ac rate appears to be sub-par. Prev-am is a oil based contact material and demonstrated good initial activity. Soil injections of 16 and 32 oz/ac of Admire were very effective against WWF, and there were no detectable differences between the two rates. Previous experiments with soil injections of Admire in citrus suggested that as much as six weeks needs to pass before the trees have enough time to adequately take up the Admire from the soil. However, these data suggest that smaller trees, about 10 ft tall, may require as little as two weeks to pick up the material.

Introduction

Woolly whitefly (WWF), *Aleurothrixus floccosus,* first appeared in Yuma County in dooryard citrus in 1996. Since that time it has spread throughout much of the commercial citrus grown on the Yuma Mesa. WWF causes damage by sucking phloem sap, which causing leaves to wilt and drop when populations are large. Honeydew droplets collect dust and support the growth of sooty mold; large infestations where copious amounts of honeydew are produced, can result in the blackening of entire trees. This reduces photosynthesis, resulting in decreased fruit size. Honeydew and sooty mold can also contaminate the fruit. Although this contamination can be washed off at the packing shed, harvest is slowed in infested groves and harvest crews are hesitant to pick heavily contaminated fruit.

WWF infestations often appear to be flared by insecticide applications targeting citrus thrips, *Scirtothrips citri*. This probably occurs due to the elimination of parasitic wasps, *Eretmocerous* spp. by the insecticides targeting the thrips. Because of the lack of a sufficient number of selective insecticides for controlling citrus thrips, flaring WWF is unavoidable during most years. Where *Eretmocerous* spp. have been found parasitizing WWF and where they were not eliminated by broad-spectrum insecticides, WWF populations are usually reduced to negligible levels. Because of the effectiveness of *Eretomocerous* spp. in controlling WWF, it is important that we identify insecticides that are

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efficacious towards WWF, yet have little impact on *Eretomocerous* spp. However, in cases where heavy WWF infestations occur in the absence of *Eretomocerous* spp., it is important to identify fast acting broad-spectrum insecticides that quickly reduce the WWF populations.

The goal of this study was to evaluate the efficacy of a several foliar insecticides and soil applications of Admire for control of WWF on flood irrigated citrus.

Materials and Methods

All studies were conducted on flood irrigated 10-year old 'Ruby Red' grapefruit grown on the Yuma Mesa near Yuma, Arizona. The soil type was Superstition Sand. Foliar-applied insecticides consisted of an untreated check, Esteem 0.86EC at 10oz/ac, Provado 1.6F at 10 and 19 oz/ac, Applaud (70 WP) at 0.5 and 0.75 lbs/ac, Prev-am at 0.4% v/v, and Danitol 2.4EC at 16 oz/ac + Lorsban 4E at 1.5 qt/ac. The treatments were applied on 1 July 2004 using an air-assisted vertical boom, calibrated to deliver 100 gal/ac. Evaluations were made on 8, 13, 20 and 27 July, 3, 10 and 17 August.

Soil-applied insecticides treatments included: an untreated check, Admire 2F at 16oz/ac and at 32 oz/ac. Treatments were applied on 21 June, 2004. The injection implement consisted of two injection shanks spaced 6 ft apart and with a forward shank to open the furrow. The treatments were injected approximately 8 inches deep at a spray volume of 9 gal/ac at 20 psi. The shanks were positioned laterally to place the product near the tree's drip line. Evaluations were made on 8, 13, 20 and 27 July, 3, 10 and 17 August.

Adult WWF were sampled by in field by counting their number from 10 new fully expanded leaves per plot. The eggs, nymphs and eclosed pupae were estimated by removing five fully expanded leaves per plot, transporting them to the laboratory, and counting their number on the underside of the leaf using a dissecting microscope. All data were analyzed using ANOVA and an F protected LSD ($P \leq 0.05$).

Results and Discussion

Foliar-Applied Test

At seven days after treatment (DAT), Danitol + Lorsban was the only treatment that contained statistically fewer adult WWF than the untreated (Table 1). Esteem and Applaud were not expected to affect WWF adult populations shortly after application because these materials are IGRs and primarily affect immatures stages, or in the case of Esteem, also cause adult sterility. There were no significant differences among any of the treatments in the number of immatures at 7 DAT. By 12 DAT, along with Danitol + Lorsban, Provado at 19 oz/ac had fewer adult WWF than the untreated. Danitol + Lorsban and Provado at 19 oz/ac also contained fewer eggs and small nymphs. At 19 DAT, all of the insecticides had fewer eggs and large nymphs than the untreated. The Applaud treatments were the only insecticides that did not differ from the untreated in the number of adult WWFs and small nymphs at 26 DAT, and all of the insecticides had fewer large nymphs than the untreated (Table 2). This observation was not surprising since Applaud in known to cause mortality primarily at the large nymph stage. There were no detectable differences among any of the treatments at 33 DAT, but at 40 DAT Esteem, which causes female WWF sterility had fewer eggs than the untreated. At this time the low rate (10 oz/ac) of Provado had more eggs than the untreated, and did not differ from the untreated in small nymphs. All of the insecticides had fewer large nymphs than the untreated. By 47 DAT, Provado at 10 oz/ac and Prev-am did not differ from the untreated in adult WWF (Table 3). None of the treatment differed from the untreated in the number of eggs, and only Esteem contained fewer small nymphs than the untreated.

Overall, Danitol + Lorsban was the best knock-down treatment evaluated, but for sustained control, Esteem was very effective. Applaud demonstrated good activity, but the rate we tested may be a little low; the 1.0 lb/ac rate should be evaluated. Provado at 19 oz/ac was a good treatment, while the 10 oz/ac rate appears to be sub-par. Prev-am is a oil based contact material and demonstrated good initial activity.

Soil-applied Test

Soil injections of Admire at 16 and 32 oz/ac appeared very effective in this test although there was a great deal of variability. There were fewer adult WWF in the Admire treatments at 12, 26 and 47 DAT, and fewer eggs on all sample dates beginning at 19 DAT (Table 4). Although Admire will kill adult and immature whiteflies, a great deal of its activity may come from its repellency. Many whitefly species and other sucking insect avoid laying eggs on plant tissue containing Admire. In addition to fewer adult WWF and eggs, there were fewer small and large nymphs in the Admire-treated plot at 12 DAT and beyond. At no point was the 32 oz/ac rate of Admire superior to the 16 oz/ac rate. Previous experiments with soil injections of Admire in citrus suggested that as much as six weeks needs to pass before the trees have enough time to adequately take up the Admire from the soil. However, these data suggest that smaller trees, about 10 ft tall, may require as little as two weeks to pick up the material.

Table 1. Mean number of adult and immature woolly whiteflies on fully expanded grapefruit leaves 7, 12 and 19 DAT, Test 1[a].

	8 July (7 DAT)					13 July (12 DAT)					20 July (19 DAT)				
Treatment/Rate	Adults	Eggs	SN	LN	EP	Adults	Eggs	SN	LN	EP	Adults	Eggs	SN	LN	EP
Untreated	54.20abc	72.90a	52.80a	26.90a	12.85a	31.50ab	16.30bc	29.65a	48.85a	12.40a	--	8.75a	6.55a	38.30a	20.35a
Esteem 10 oz/ac	66.50ab	65.65a	28.25a	19.80a	15.25a	35.00ab	18.95b	14.60abc	20.25bc	1.90a	--	2.40b	4.40a	18.25b	1.50a
Provado 10 oz/ac	16.50cd	47.70a	24.90a	5.75a	18.00a	15.00bc	2.70cde	25.40ab	34.55ab	7.35a	--	0.90b	1.65a	9.35bc	6.45a
Provado 19 oz/ac	12.00cd	20.80a	8.95a	4.05a	10.20a	7.75c	2.05ed	11.80bc	47.60a	7.35a	--	0.55b	2.40a	6.65bc	2.45a
Applaud 0.5 lb/ac	83.25a	69.05a	35.95a	20.40a	8.50a	34.50ab	5.58bcde	14.40abc	18.00bc	8.25a	--	2.40b	3.65a	10.60bc	7.50a
Applaud 0.75 lb/ac	66.25ab	40.00a	17.05a	12.75a	11.85a	38.25a	45.85a	21.80ab	38.50ab	3.70a	--	2.55b	1.70a	6.10bc	12.40a
Prev-am 0.4%v/v	24.00bcd	36.40a	14.50a	4.55a	8.60a	21.75abc	14.10bcd	17.75ab	12.10bc	1.50a	--	2.80b	3.00a	5.25c	2.55a
Danitol 16 oz/ac +Lorsban 1.5 qt.ac	2.00d	19.65a	1.30a	1.95a	18.25a	4.25c	0.05e	0.05c	1.40c	16.70a	--	0.55b	1.25a	0.75c	9.20a

Means in a column followed by the same letter are not significantly different; ANOVA, F protected LSD ($P > 0.05$).
[a]SN = small nymphs, LN = large nymphs, and EP = eclosed pupae.

Table 2. Mean number of adult and immature woolly whiteflies on fully expanded grapefruit leaves 26, 33 and 40 DAT, Test 1[a].

	27 July (26 DAT)					3 August (33 DAT)					10 August (40 DAT)				
Treatment/Rate	Adults	Eggs	SN	LN	EP	Adults	Eggs	SN	LN	EP	Adults	Eggs	SN	LN	EP
Untreated	41.50a	3.35a	12.90a	81.15a	14.85a	68.50a	10.45a	2.80a	17.65a	17.65a	96.25a	53.55b	23.05a	60.65a	13.10a
Esteem 10 oz/ac	8.25c	1.60a	1.75c	20.65bcd	3.45a	18.00a	1.65a	1.10a	7.80a	3.50a	18.50a	4.30c	0.65c	12.95b	4.55b
Provado 10 oz/ac	17.25bc	2.90a	0.95c	16.45cd	4.75a	35.50a	34.33a	4.70a	9.45a	6.00a	72.00a	104.60a	17.40ab	4.80b	6.05a
Provado 19 oz/ac	12.75bc	2.70a	1.05c	12.55cd	4.25a	50.25a	5.60a	1.10a	5.35a	4.80a	49.75a	23.05bc	5.00bc	7.25b	8.40a
Applaud 0.5 lb/ac	26.25ab	2.10a	10.55ab	40.45b	8.30a	78.75a	18.15a	2.75a	7.75a	3.15a	54.25a	10.30bc	3.35c	22.40b	8.85a
Applaud 0.75 lb/ac	39.00a	12.25a	6.75abc	35.30bc	3.75a	46.25a	21.45a	2.95a	10.80a	7.75a	54.50a	24.80bc	3.25c	18.15b	11.25a
Prev-am 0.4%v/v	16.25bc	17.85a	4.60bc	28.35bc	3.05a	20.50a	12.65a	4.40a	11.70a	9.35a	41.50a	9.45bd	2.10c	12.90b	7.50a
Danitol 16 oz/ac +Lorsban 1.5 qt.ac	2.75c	1.00a	0.75c	2.20d	11.55a	9.00a	0.80a	0.35a	1.60a	3.45a	15.25a	5.40bc	0.30c	0.88b	3.00a

Means in a column followed by the same letter are not significantly different; ANOVA, F protected LSD ($P > 0.05$).
[a]SN = small nymphs, LN = large nymphs, and EP = eclosed pupae.

Table 3. Mean number of adult and immature woolly whiteflies on fully expanded grapefruit leaves 47 DAT, Test 1[a].

	17 August (47 DAT)				
Treatment/Rate	Adults	Eggs	SN	LN	EP
Untreated	109.75a	21.85abc	8.35a	16.40b	34.10a
Esteem 10 oz/ac	39.75cd	4.38c	1.30b	9.20b	5.60b
Provado 10 oz/ac	72.50abc	39.35a	31.75a	7.25b	10.35a
Provado 19 oz/ac	38.50cd	9.65bc	12.85a	3.60b	9.40a
Applaud 0.5 lb/ac	110.00a	26.25ab	12.30a	38.38a	19.40a
Applaud 0.75 lb/ac	53.75bcd	8.95bc	5.65a	13.35b	17.53a
Prev-am 0.4%v/v	97.00ab	10.70bc	8.45a	12.20b	9.75a
Danitol 16 oz/ac +Lorsban 1.5 qt.ac	14.50d	6.90bc	4.10a	1.05b	5.20a

Means in a column followed by the same letter are not significantly different; ANOVA, F protected LSD ($P > 0.05$).
[a]SN = small nymphs, LN = large nymphs, and EP = eclosed pupae.

Table 4. Mean number of adult and immature woolly whiteflies on fully expanded grapefruit leaves 7, 12, 19, 26, 33, 40 and 47 DAT, Test 2 [a].

Treatment/Rate	Adults	Eggs	SN	LN	EP
			8 July (7 DAT)		
Untreated	54.50a	72.90a	52.80a	26.90a	12.85a
Admire 16 oz/ac	2.50b	1.25a	1.45a	2.10a	9.00a
Admire 32 oz/ac	5.50b	2.45a	1.58a	3.45a	25.75a
			13 July (12 DAT)		
Untreated	31.50a	16.30a	29.65a	48.85a	12.40a
Admire 16 oz/ac	1.50b	0.35a	0.10b	1.25b	14.75a
Admire 32 oz/ac	1.75b	3.45a	2.40b	4.50b	8.75a
			20 July (19 DAT)		
Untreated	--	8.75a	6.55a	38.30a	20.35a
Admire 16 oz/ac	--	0.15b	0.05b	0.65b	13.80a
Admire 32 oz/ac	--	0.60b	0.15b	1.80b	14.85a
			27 July (26 DAT)		
Untreated	41.50a	3.35a	12.90a	81.15a	14.85a
Admire 16 oz/ac	2.00b	0.30b	0.00b	0.25b	19.80a
Admire 32 oz/ac	4.25b	0.30b	0.55b	2.55b	20.40a
			3 August (33 DAT)		
Untreated	68.50a	10.45a	2.80a	17.65a	17.65a
Admire 16 oz/ac	4.50a	1.20b	0.20b	0.20b	7.45a
Admire 32 oz/ac	4.00a	2.25ab	0.30b	0.30b	11.35a
			10 August (40 DAT)		
Untreated	96.25a	53.55a	23.05a	60.65a	13.10ab
Admire 16 oz/ac	5.00a	0.15b	0.05a	0.55b	16.85a
Admire 32 oz/ac	4.50a	0.00b	0.00a	0.35b	5.05b
			17 August (47 DAT)		
Untreated	109.75a	21.85a	8.35a	16.40a	34.10a
Admire 16 oz/ac	6.50b	0.10b	0.10b	0.05b	4.15a
Admire 32 oz/ac	13.00b	0.00b	0.05b	0.52b	11.98a

Means in a column within a date followed by the same letter are not significantly different; ANOVA, F protected LSD ($P > 0.05$).
[a]SN = small nymphs, LN = large nymphs, and EP = eclosed pupae.